CHAPTER III

METHODS AND PROCEDURE

3.1 INTRODUCTION.

In order to make the present study a fruitful one, the investigator consulted available literature on the subject, to collect as much information as possible about the work done in the area of teaching and learning mathematics, so that she can equip herself with experience to probe into the subject scientifically and systematically. The present chapter is devoted to the method and procedure adopted to make the study a successful one.

3.2 RESEARCH METHOD.

A number of methods are suggested by authors like Sukhia, Mehrotra and Mehrotra (1982) and Sidhu (1992) for research purpose. Out of these methods the investigator applied the Normative Survey method in the present study.

According to Sukhia, Mehrotra and Mehrotra (1982) some characteristics of Normative Survey Method are the following:

1) Normative Survey Method is essentially cross-sectional
2) It gathers data from a relatively large number of cases.
3) It is concerned not with the characteristics of individuals but with generalised statistics for the whole population or a representative sample.
4) It deals with clearly defined problems and has definite objectives.
5) It requires an imaginative planning, a careful analysis and interpretation of the data and a logical and skilful reporting of the findings.

6) It provides information useful to the solution of local problem.

7) In the vast range of phenomena performing the subject of educational area including pupils’ ability to learn or the results of learning viz. achievement, basic skills, information, interest, attitude etc. the Normative Survey method is one of the best methods for educational research.

Good (1941) remarked that no other unified undertaking so fully represents Normative Survey of research in all its various phases, as does the school survey. The present study concerns with school survey only.

Reviewing all these points the investigator thought that the Normative Survey Method would be the most suitable one for an intensive study of the factors related to the present study, where the word survey indicates the collection of data, regarding current condition and the word 'normative' is used because surveys are frequently made for the purpose of ascertaining which is normal or typical condition.

3.3 STATEMENT OF THE PROBLEM.

The topic selected for the present study reads as “A study on some problems of learning Mathematics at Secondary Stage with relation to High Schools in Greater Guwahati.”
3.4 CONCEPTUAL AND OPERATIONAL DEFINITION OF TERMS USED IN THE STUDY.

STANDARD - By the term standard or stage in the present study, the investigator means the academic or school grades of pupils. In this study pupils are selected from Standard X only.

STUDY - To search, to investigate, to look minutely into.
In the present study, the term is used to mean a scientific investigation or research.

PROBLEM - The educationists and psychologists define "problem" as a question proposed for solution by research or by any kind of investigation.

The field of education is a vast one and as such unsolved problems in the educational field are numerous and of varied nature. The educationists and psychologists, including Sukhia, Mehrotra and Mehrotra (1982), classified these problems under various stages and secondary education stage is one of them.

The teacher and the taught have to face problems of varied nature in teaching and learning process- particularly in the school stage.

The defective and unplanned curriculum, defective textbooks, size of the classroom, improper teacher student ratio, anomalies in examination system, and various other factors may create problems in the process of teaching and learning. Moreover the factors both cognitive and affective, such as interest in, attitude and anxiety towards different school subjects, various levels of intelligence of the pupil, different order of skills in handwriting, reading, spelling, problem solving capacity of the pupils, related
to psychology of individual learner are responsible in creating problems in learning and teaching.

The central focus of educational research is the all-round development of the pupil, which is possible only when the researcher can go deeper to identify the factors responsible for creating problems in the field of education, which may be called the "unsolved difficulties" both in India and abroad. The insightful research helps to study those problems in order to find out ways and means for solving these problems.

In the present study by the term "problem" the investigator means some "difficulties" faced by the pupil of secondary stage because of some responsible factors in learning mathematics in the secondary schools stage.

**LEARNING** - The study of the process of learning has a long history. The names of Locke *(1632 - 1705)* and David Hartley *(1714 - 1757)* may be mentioned here who created landmarks in the study of learning. But the name of Thorndike *(1874-1949)* is most closely associated with the study of the nature and scope of the learning process.

*Thorndike (1932)* has laid down three laws of learning. They are:

1) Law of readiness
2) Law of reception plus belongingness
3) Law of effect

*Thorndike (1932)* holds that these laws express the conditions under which connections are formed and results learnt. He maintained that the mind is the connection system of human being and learning is the process of connectivity.
Readiness: When the learner is allowed to do something according to his own will he is pleased and if he is compelled to do something against his will he is annoyed - this situation is termed as readiness. and by the term belongingness a response must be felt to belong to the stimulus.

Effect expresses the conditions under which connections are formed and results learnt.

Thorndike's Law of effect states that learning is likely to be more permanent in the learner if it is accompanied by satisfaction rather than dissatisfaction.

Repetition: - By the term repetition Thorndike maintained that the more a given response is connected with a certain situation, more likely it is to be made to that situation, and lesser connection is made with certain situation, the strength of the connection decreases.

This theory developed by Thorndike (1932) that learning consists essentially in connecting of a response R to a stimulus S (S-R) which did not originally call forth that response is known as "Stimulus-Response (S-R) Theory of Learning" and it is widely accepted by the educationists and psychologists of modern era.

Motivation is the very heart of learning process, especially in learning mathematics. The various aspects of motivation are incentive, interest, drive and purpose. Proper motivation sets in motion the activity, which results in learning. Mainly two kinds of motivation are recognised by the psychologists. They are

1) intrinsic
2) extrinsic
Sorenson (1954) maintained that motivation is intrinsic when it is within a person and is extrinsic when it comes from outside. When teachers try their best to make subject matters meaningful and interesting to the learner— that motivation is said to be intrinsic, and extrinsic motivation is external to learning, such as praise, reward, etc. Praise is the most effective stimulus in motivating the learner extrinsically. The psychologists suggest that both types of motivation can help the learners to learn easily.

Learning has been defined by McGoeth J.A. (1942) as a change in performance, as a function of practice. He observed that in most cases, if not in all, this change has a direction, which satisfies the current motivating conditions of the individual.

Lewin K. (1942) emphasized that learning is the organisation of behaviour which results from many interacting influences on the developing organism acting in its shifting environment - in this process the learners find it new and reorganise the old in terms of new event and perceive significant factors involved

Rudolf Printer, John J. Raym, Paul V. West and other psychologists (1963) emphasised that one of the important problems of educational psychology is the problem of learning, which includes the following factors.

1) consideration of response to learning
2) practice and drill
3) motivation
4) methods of learning
5) ability to learn
6) transfer of training
7) psychology of school subject
8) intellectual understanding
9) distribution of characteristics among individuals and groups
10) analysis of differential needs and
growth including rate, stage and types of growth among individual

*Pinter and others* (1963) pointed out that three factors condition learning.

(a) Motivational,
(b) Physiological 
(c) Environmental.

According to them in the classroom teaching adequate motivation in the subject concerned can create interest in the pupils' mind which can help the learners to learn easily.

Proper Environmental factors which prevails in the school, home and locality and society accelerate the process of learning.

Physiological factor is the general tone of organism, which relates to the five important senses recognised by tradition i.e. sight, hearing, taste, smell and touch which are known as five gateways of knowledge. The less or deficit in way of these five senses, especially of vision or hearing, becomes hindrance in the process of learning. Poor teaching method, different curriculum, atmospheric condition etc. are responsible for catering mental fatigue, strain and lack of interest. The Psychologists observe that particularly during the secondary school stage, girls are more susceptible to strain and worry than the majority of boys.
As pointed out by Kundu and Tutoo (1989), Marquis has defined learning in the following way: "It represents a modification of the organismic pattern in response to specific stimuli present in the external environment at the time of the modification."

Kundu and Tutoo (1989) defined learning as modification through experience. According to them learning is the modification and co-ordination of the responses of the organism. In learning, according to the most of the psychologists, there is an interaction of the environment with the organism.

Witrock (1974) emphasised that learning of mathematics is a cognitive process.

Proper investigations of this educational psychology help teachers and researchers in the educational field to gain understanding of the pupils' problems in the learning process. Study of the proper conditions of learning helps teachers to adjust their activities to the requirements of the pupils. The emotional condition of the pupil is strongly related with their success and failure, low achievement and high achievement which is the end product and outcome of learning. Insightful learning has full impact on the classroom. It is the duty of the teacher to present the whole problem in such a way that it evokes the cognitive and emotional readiness in the learner.

The goal of learning deals with the acquisition of knowledge, understanding thereby intellectual and emotional modification and control and acquisition of skill.

Most desired outcome of learning for the student community, particularly in our country, where the whole education system is examination oriented, reflects on the achievement of the pupil in various examinations. Kundu and Tutoo (1989) remark that success and failure in examination
accordingly determine the learning in a person. They observe that relationship of success and failure to mental health exists in the same way as in the relationship between the mind and the body. The emotional condition of the pupil greatly changes by success or failure which influences the end product of learning and which is measured by the achievement in examination conducted by respective institutions. The teacher plays a vital role in rendering learning of the pupil effective by making the subject matter interesting.

In the present study the investigator is interested in the problems of learning mathematics by the pupils of the secondary school stage.

In the present study by the term "learning" the investigator means the process of acquisition of knowledge through the teacher in the class room and achievement in annual examination in mathematics from standard IX to standard X is considered as the pupils' measure of learning mathematics in high school stage.

**INTEREST** :- Various schools of Psychology have tried to give their respective emphasis on interest. According to some of these, interest may be looked upon as an emotional attitude which arranges our activities in a subjective scale of values where subjective value is determined by the appeal which it makes to the subject.

*Herbaria (1989), McDougall (1946)* and other psychologists and philosophers have engaged themselves in exploring the quantitative and qualitative aspects of interest and they have attempted to define interest so as to evolve a definite inventory of criteria regarding its basic meaning. Interest has been defined by educationists and psychologists as preferences, drives, feelings of satisfaction etc. They discussed interest as a form of
selective awareness or attention that produces meaning out of the mass of one's experience.

They speak of interests as "likes" and labels "dislikes" as "aversions".

Nile and Constance (1962) maintained that interest patterns are learned tendency to respond selectively, positively and with accompanying satisfactions to certain features of environment, encourage a person to participate eagerly in a particular activity, whether it is a game or school work, reading a book, writing about something or doing sums etc.

Dictionary on Psychology tells us that interest has variety of meanings including - "The tendency to give selective attention to something", and "A tendency to engage in an activity solely for the intention of engaging therein".

Selective factors operate very much in an individual's interest. Getzel (1956) pointed out the following determinants of interests.

(I) Constitutional or physical capabilities,
(ii) Inborn qualities
(iii) Personality
(iv) Various socio cultural factors
(v) Role requirements of a person
(vi) Family influences
(vii) Accidental events.

As Kundu and Tutoo (1989) cited, psychologists and educationists classified interest under four groups depending upon how information about them is obtained.
Super as cited by *Kundu and Tutoo (1989)* has identified interest groups as follows:

1. Expressed interest
2. Manifested interest
3. Interest inferred from test.

Expressed interests are identified by asking a pupil to tell or write about the activities which a person most or least enjoys.

Manifested interest may be identified by observing the pupils hobbies and other activities. In the present study the investigator is interested in expressed interest of the pupil – interest in mathematics.

Social scientists and psychologists are always giving emphasis on the measurement of interest. Many instruments have been invented to measure different interests among individuals. Tests and scales, with a real psychological content and constructive and intelligible psychological meaning have been produced. One of these instruments is Interest questionnaire.

In the present study by the term “interest” the Investigator means concern or preference shown by individuals for any particular object or class of objects.

More strictly speaking during the investigation the particular class of objects is considered to be the Secondary Stage School Subject - Mathematics.

**INTELLIGENCE:-** History of educational psychology reminds us that ancient Greek philosophers and medieval scholars were aware of the idea of a unitary co-ordinating “mental” faculty. The systematic theories and
extensive empirical investigation of intelligence developed mainly after 1850. Principal formulators of the modern concepts were Herbert Spencer (1820 - 1903) and Sir Francis Galton (1822 - 1911).

Since then psychologists and educationists engaged themselves in study and research works to explore the very meaning of the term intelligence and about its definition, concepts and measurement. Their options vary surprisingly about the definition of intelligence, which can be categorised under the following heads:

I) Intelligence is a single ability common to all intellectual process,

ii) Intelligence is a group of two or three abilities

iii) Intelligence has no real entity but is merely a convenient term for the average of all specific abilities.

Many psychological definitions throw light on important aspects of human intelligence. *L.M.Terman (1937)* defines intelligence as "the ability to carry on abstract thinking"

*Burt (Jrnl. of Exper Ped, 95)* maintained that intelligence is an "inborn all-round mental efficiency". *Woodrew (Jrnl. Of Educational Psychology XII, 208)* defines it as capacity to acquire capacity.

Social scientist and psychologist Thorndike has defined intelligence as the power of making good responses from the point of view of truth and fact.

*Binet* (*"L" intelligence des imbeciles " in L'Annee Psychologique (1909) 1-147) regards intelligence as involving at least three factors. Psychologists *Terman* (1937), *Measurement of Intelligence P.45* summarised these factors as follows:

i) The tendency to take and maintain a definite direction
ii) The capability to make adoptions for the purpose of attaining a desired end.

iii) The power of auto-criticism.

Intelligence is such a complex factor in the region of psychology and education that, there is little agreement among the psychologists, social scientists and educationists.

*Philip, Boswood & Ballard (1957)* (pg. 137-Group test of Intelligence P.B.B.) observed that inspite of divergent and apparent inconsistency of opinion regarding meaning of intelligence majority of the theorists subscribe to the following tenets:

i) Intelligence is general mental ability, which operates in many different ways.

ii) It is more fully manifested in the higher mental process than in the lower.

iii) It is specially active in dealing with present points of novelty (in other words with the solution of problems).

iv) It is more concerned with the dissecting, planning and

v) rearranging of the data of experience than with the mere reception of impression.

*Philip, Boswood & Ballard (1957)* remarked that although the more possession of knowledge is presumptive evidence of intelligence, the power to use knowledge is evidence of much stronger kind. In his view the power to apply old knowledge to new situation is the sole criterion of intelligence. In spite of this divergent and apparent inconsistency of opinion the psychologists observe that the commonest definition of the term contain as a nucleus of notion, of adjustment, of adaptation, of conforming to new conditions.
Proceeding still further along the thorny path of definition of intelligence *Ballard (1957)* says that the intelligence is the relative general efficiency of minds measured under similar condition of knowledge, interest and habituation.

He also remarks that intelligence cannot be tested in *vacuo*, it can only be tested in relation to knowledge between two minds under same circumstance. The mind that absorbs knowledge more rapidly is the more intelligent of these two.

Psychologist *D.O.Hebb (1949)* defines intelligence under two aspects naming them as "Intelligence A" and "Intelligence B". Intelligence A refers to the basic given characteristics of the individual’s central nervous system. Intelligence B refers to developed intelligence as moulded by experience, learning and environmental factors.

But regarding its definitions and concepts psychologists and educationists maintain a variety of opinions. Although definitions vary, the common elements may be discerned. Intelligence as defined as a cognitive disposition (knowing) distinct from the effective (emotional) or motivational. Although it is defined primarily as capacity or potentiality rather than fully developed attainment, it is universally accepted as having a biological basis. Psychologists maintain that cognition manifestly is a function of the central nervous system and individual differences are related to biological genetic endowment.

But the name of *Charls Spearman (1923)* is most closely related with the modern definition of intelligence. He advanced a theory of intelligence based on general mental factor, which is designated as "g" and specific factors designated as "s". He believes that this mental factor "g", is
possessed by all individuals but in various amount and to determine the level of intelligence the amount of factor "g" should be measured. He explains that the concept of "s" factors represents the special capacities a person may have. According to him "g" factor is determined by the functioning of the brain, "s" factors depend on neurological organisation favourable to specific ability.

For the present study intelligence is regarded as the capacity for logical thinking. For the complexity of the meaning of intelligence it is very difficult to get a single test to measure all the qualities. Therefore Maduhukar Patel's Intelligence Test which measures pupil's logical thinking capability, will be used to measure intelligence (IQ) of the pupil concerned. The total score achieved by the student will be considered as the index of his mental level.

3.5 OBJECTIVE OF THE STUDY:

1. To enquire into the Achievement In Mathematics (AIM) of the pupil of standard X in the annual examination from standard IX to standard X.
2. To find out the relationship between AIM and Interest in Mathematics.
3. To find out the relationship between AIM and IQ of the pupil.
4. To find out the relationship between AIM and achievement in mathematics.
5. To find out the relationship between AIM and sex.
6. To find out the difference in AIM among the three IQ groups.
7. To find out the difference in AIM for the three intelligence groups.
8. To find out the difference in AIM for the three arithmetical ability groups.
9. To find out the difference in AIM between the two sex groups.

3.6. HYPOTHESES:

The investigator formulates the following hypotheses on the basis of findings of some previous studies.

1. There are considerable numbers of underachievers and very low achievers in mathematics among the pupils who are promoted to Standard X from Standard IX.
2. There is no relationship between Achievement In Mathematics and Achievement In Arithmetic of the pupil.
3. There is no relationship between Achievement in mathematics and interest in mathematics of the pupil.
4. There is no relationship between Achievement in mathematics and I.Q. of the pupil.
5. There is no relationship between Achievement in mathematics and gender of the pupil.
6. There is no difference in Achievement In Mathematics among arithmetical ability group.
7. There is no difference in Achievement In Mathematics among the interest groups.
8. There is no difference in Achievement In Mathematics among sex groups.
9. There is no difference in Achievement In Mathematics among intelligence groups.
3.7 LIMITATIONS OF THE STUDY

The study had the following limitations-

a. The study was limited to secondary schools of greater Guwahati alone.

b. The study had to be limited to students of standard X of Assamese medium schools alone because the results of the H.S.L.C. examinations conducted by SEBA shows that in comparison to English medium schools, percentage of failure is much higher in Assamese medium secondary schools, specially in the subjects English and Mathematics.
3.8 THE PROCEDURE

After setting the objective of the study and the hypotheses to take care of, the investigator adopted the following procedure for selection of the sample, research tools and collection of data. Thus the procedure can be divided under the following steps.

A. Selection of samples
B. Selection and description of tools
C. Administration and operation of the tools
D. Collection of Data

A. Selection of the sample

A researcher in the field of education cannot make any fruitful generalisation unless the research results are based on representative samples. The present study represents High school population covering population of standard X.

I) Selection of the Schools.

In order to investigate about the problems in learning mathematics of the Secondary level students the very first step was to select the schools from where the data were to be collected.

In the city of greater Guwahati there are more than forty high schools and higher secondary schools, medium of instruction being Assamese, English, Bengali and Hindi. The number of the Assamese medium high schools and higher secondary schools is the highest.
For the present study eight Assamese medium High Schools and two Assamese medium higher secondary schools are selected. These schools are managed by the State Government, as well as private and semi private bodies. Care was taken to see that these schools represent the population from the whole of the greater Guwahati City.

vi) Population

Population in the present study, comprises of all students of secondary level, that is pupils of Standard X only of Assamese medium schools (Secondary and Higher Secondary) of Greater Guwahati.

The pupils of Standard X are selected because this standard is the last standard of Secondary school and as such the pupils acquire as much knowledge as prescribed for them in the high school Syllabus, excepting a few chapters. Regarding achievement in Mathematics of the pupils, since it is not possible to collect marks in the final examination conducted by the Board of Secondary Education, the marks achieved by the pupils in mathematics in the last school annual examination, that is, from IX to X are collected for results of learning or the pupil’s ability to learn (achievement) mathematics.

iii) Sample

*A.L. Bowley (1754)* used the sampling method in social science. Since then the method is increasingly gaining popularity as well as utility.

*Sidhu (1984)* pointed out that in the educational field although no two students are alike in any way, beneath this apparent diversity there is an underlying fundamental unity. The students are similar in many respects so that a study of some of them will throw significant light upon the whole group.
Thus samples selected have similarity with other units to make the sampling more scientific.

Some of the characteristics of a good sample according to Sukhia, Mehrotra and Mehrotra (1963) are listed below.

1. A good sample is one, which, within restriction imposed by its size, will reproduce the characteristics of the population with the greatest possible accuracy.
2. A good sample should be free from
   a) error due to bias and
   b) random sampling error.
2. Sample in a survey method should be large enough as to yield reliable result.
4. Sample should be representative of the total population.

The most commonly used sampling method quoted by Garrett (1971) are

   i) Random
   ii) Stratified
   iii) Incidental and
   iv) purpose

Sukhia, Mehrotra and Mehrotra (1963), Sidhu (1984), Garrett (1971) pointed out various advantages of random sampling in a survey method of study. Some of these advantages can be listed as below.

   i) In the random sampling method every single unit of population has an equal chance of being selected.
   ii) It is more representative of the population
vii) The degree of discrepancy likely to occur in any given sample can be determined by probability method.

iv) The method is simple to use

Considering all these advantageous factors the investigator selected Random Sampling method for the present study to get unbiased cross section of the population.

In Random Sampling method samples can be drawn by following 'The Fischer-Yates Tables' (1963) by taking out every fifth or tenth number from the field catalogued population or by lottery method.

In the present study the investigator selected twenty-five students from two sections of Standard X randomly from class register with the help of lottery. And in those classes where there were three sections sixteen students from each of two sections and eighteen students from the remaining section were selected following the same procedure. Care was taken to select equal numbers from both the sexes in the co-education schools wherever it was possible. Each section consisted of pupils of heterogeneous quality and hence the nature of the population was normally distributed and the sample could be considered representative.

B. Selection and description of the tools.

For each and every type of investigation one must use suitable tools related to the objective of the investigation to measure the variables undertaken to arrive at some fruitful conclusion.
According to Best (1986), some of the data gathering devices widely used in educational research are:

I) Psychological test and inventories
II) Questionnaires
III) Rating scales
IV) Interviews etc.

I) Test:

Best (1986), remarked that as data gathering devices, tests are the most useful tools in educational research. He adds that these tests yield objective and standardised description of behaviour, quantified by numerical scores, making it possible to have more precise analysis, than can be achieved through subjective judgement alone.

The tests are the instruments designed to describe certain human behaviour. There are different types of psychological tests, which include:

i) Performance test
ii) Paper pencil test
iii) Standardised test
iv) Teacher made or investigator made test
v) Power test
vi) Timed or speed test etc.

For the present study the investigator selected two ready made standardised tests, one for measuring intelligence and other for assessing level of interest in mathematics of the pupils. To measure arithmetical ability, the investigator constructed one Arithmetical Ability Test questionnaire.
In the present study the investigator had to construct one questionnaire to assess the attitude towards the different topics of the course content of the High School Leaving Certificate examination. *Good and Halt (1952)*, described questionnaire, as a drive for securing answers to question by using form, which the respondent fills in himself/herself. *Barr, Davis and Johnson (1951)*, define questionnaire as "a systematic compilation of questions that are submitted to a sampling of population from which information is desired". According to *Sukhia, Mehrotra and Mehrotra (1974)*, the questionnaire is the most flexible of tools, which possesses unique advantages over other kinds of tools in collecting both qualitative and quantitative information. Moreover it makes it possible to economise time and expenditure to the placement of a number of responses in one place.

The investigator expected that the questionnaire selected for this study would be more effective to the problem under study.

The following tools were finally selected and employed in the present study:

i) Arithmetic Ability Test constructed by the investigator to assess arithmetic ability of the pupil of Standard X.

ii) A questionnaire constructed by the investigator to assess attitude towards different topics in mathematics included in the syllabus for High School Leaving Certificate examination, conducted by the Board of Secondary Education, Assam (SEBA).

iii) Standardised Mathematical Interest Inventory by *L.N.Dubey (Educational Psychology and Guidance College, Jabalpur)* to measure interest level of the pupils.

iv) The M.P.T.I. or Madhukar Patel's Non-Verbal Intelligence Test to measure Intelligence.
v) Marks acquired by each student in mathematics in the previous annual examination of the school were collected from the school records to have Achievement in Mathematics.

II (i) Construction of Arithmetical Ability Test Questionnaire

It is universally granted that in developing mathematical understanding and in learning mathematics rich arithmetical background is of much importance. Fundamental mathematical concept of a pupil is based on his arithmetical concept. Arithmetic plays a vital role in nurturing the mathematical powers of the individual student. Through the present study, the investigator wants to measure pupils' arithmetical ability and its influence on their achievement in mathematics. Prepared Arithmetical Ability Test in Assamese language, which is the medium of instruction of all the schools under study had not been available during the time of investigation. The investigator had to prepare an Arithmetic Ability Test in Assamese of High School Standard for assessing arithmetical ability of the pupils selected for the study.

To gather some knowledge regarding the norms to be followed in constructing the test, the investigator consulted related literature on basic arithmetical concept and its bearing on mathematical learning of the pupil.

A brief account of the topics included in the Arithmetic Ability Test are given below:

- In constructing the test care was taken to include almost all topics related to basic concept in arithmetic, as far as possible which are considered of utmost importance during the school stage of the students as well as their future life.
Keeping in view the importance and usefulness of the mathematical operation order rule, popularly known as “BODMAS”, (Bracket, of, Division, Multiplication, Addition and Subtraction) operation six questions viz. question numbers 1, 2, 3, 4, 5, and 6 are selected under the mathematical operation order rule. To inquire about the pupils’ ability in the area of mathematical operations addition, subtraction, multiplication and division (+, -, x and ÷) with the decimal numbers question numbers 7, 8, 9, 10, 11, 12 and 13 are included in the test. It is evident that concept of percent is one of the most useful concept for the pupil not only in the school mathematics curriculum but also in many social activities.

However despite its practicability and prevalence, percent is one of the most difficult topics for students and adults to conceptualize and to develop facility in using students’ low performance in the area of percent is well documented by (Lindquist, 1989).

The study in the area of pupils’ concept of percent by Bruckner (1930), Edwards (1930), Guiler (1946a, 1946b), Montgomery (1958), Allinger (1990), pointed out students’ low percentage in percent related problems. Considering all these points regarding concept of percent, question numbers 14, 15, and 16 are included in the test.

To touch the different areas of percent concept the questions are selected as follows:

Q. No. 14. Relation between Decimal and Percentage
Q. No. 15. General concept of percent
Q. No. 16. Relation between percent and fraction

To assess the pupils’ concept about magnitude of positive and negative fractional numbers, question numbers 17, 18 and 19 are selected.
Question numbers 20 and 21 are included to assess the visualisation capacity of the pupil. To have knowledge of generalisation capacity of the students, which is very important in the world of mathematics question numbers 22, 23 and 24 are selected for the test.

Ratio and proportion are also important concepts in current mathematics curriculum. Because of the importance of this topic in school mathematics, children's concept of ratio and proportion has long been a focus of mathematics education research. The studies by Hart (1984), Karplus, Pulos & Stage (1983) on concept of ratio and proportion of the students brought to light students' errors and difficulties in solving ratio and proportion tasks. Findings of their studies on “Developing ratio and proportion concept by the school level students” revealed that development of ratio and proportion concept is embedded within the development of the multiplicative conceptual field.

After consulting these studies the investigator decided to include two questions No.25 and No. 26 in the A.A.T. test to inquire about the concept of the pupil regarding ratio and proportion.

The remaining questions selected for the test are related to common arithmetical knowledge included in the High School arithmetical curriculum i.e. L.C.M. Q no. 28, H.C.F. Q, No. 27. profit and loss Q. No. 30, and unitary method No. 29. Selections of the test questions in the Arithmetical Ability Test under different areas of inquiry are shown in Table 3.1

The A.A.T, thus constructed was tried out on a group of students of Standard X of a co-education school to see the feasibility of the test and the response of the pupils and thus to inquire if there was any difficulty on the part of the pupil in answering the questions. Out of these 90 selected students, 46 were boys and 45 were girls. The try-out was used as time
bound test. The time allotted for the test was 40 minutes i.e. Mathematics period in the class routine for class X of which 30 minutes for answering the 30 questions and 10 minutes for filling the bio data of the student and for explaining the test items and methods, and for answering the questionnaire on course content.

The students scored one score for each correct answer. The students in the try-out group were divided into two halves - top and bottom on score - care being taken to have 50% representation in each half. The items of the two halves of students were evaluated by considering the difficulty and discrimination values. The details of evaluation for validity of test items considering Difficulty and Discrimination values are given in the following table (Table No. 3.1).

In the table evaluation of each of the thirty items of the A.A.T. is shown. Here four figures obtained for each item have been named and defined as follows:

\[
\begin{align*}
H &= \text{The number of highs who got the item correct} \\
L &= \text{The number of lows who got the item correct} \\
H + L &= \text{Total number who got the item correct} \\
H - L &= \text{‘Discrimination’ or ‘the high-low difference’ denoting how many more highs than lows got the item right.}
\end{align*}
\]
### Table 3.1
EVALUATION OF AAT CONSIDERING DIFFICULTY AND DISCRIMINATION VALUES

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Head</th>
<th>Item No.</th>
<th>Items</th>
<th>High Total Correct</th>
<th>Low Total Correct</th>
<th>H+L</th>
<th>H-L Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Operation</td>
<td>BODMAS</td>
<td>1. $3/4 \div 3/4 \times 3/4 = ?$</td>
<td>15</td>
<td>5</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>Mathematical operations</td>
<td>$\frac{3}{4} \div 3/4 + 3/4 = ?$</td>
<td>13</td>
<td>3</td>
<td>16</td>
<td>10</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>$1/2 + (1/2 \div 1/2) = ?$</td>
<td>17</td>
<td>6</td>
<td>23</td>
<td>11</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>$4 - [5 + 1 - (4-3)] = ?$</td>
<td>35</td>
<td>24</td>
<td>59</td>
<td>11</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>$11 \frac{2}{3} \div 9 \frac{3}{8}$ of $5 \frac{3}{5} = ?$</td>
<td>16</td>
<td>4</td>
<td>20</td>
<td>12</td>
<td>✓</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>$3 \frac{4}{5} - (1 \frac{1}{2} + 1 \frac{1}{2} + 1 \frac{12}{25}) = ?$</td>
<td>27</td>
<td>14</td>
<td>41</td>
<td>13</td>
<td>✓</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>$.999 + .999 + .99 = ?$</td>
<td>31</td>
<td>11</td>
<td>42</td>
<td>20</td>
<td>✓</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>$21.7 + 13.21 + 15.721 = ?$</td>
<td>35</td>
<td>13</td>
<td>48</td>
<td>22</td>
<td>✓</td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>$1.5 + .05 - 1.55 = ?$</td>
<td>40</td>
<td>21</td>
<td>61</td>
<td>19</td>
<td>✓</td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>$640 \div 04 = ?$</td>
<td>26</td>
<td>12</td>
<td>38</td>
<td>14</td>
<td>✓</td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>$(.09)^2 = ?$</td>
<td>28</td>
<td>16</td>
<td>44</td>
<td>12</td>
<td>✓</td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>$1309 = ?$</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>11</td>
<td>✓</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>$(.1)^3 = ?$</td>
<td>22</td>
<td>9</td>
<td>31</td>
<td>13</td>
<td>✓</td>
</tr>
<tr>
<td>14.</td>
<td>Percentage</td>
<td>(a) general</td>
<td>$5%$ of Rs. 20,000/- = ?</td>
<td>29</td>
<td>13</td>
<td>42</td>
<td>16</td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>(b) Relation betn. % and decimal</td>
<td>Express $9%$ in decimal</td>
<td>33</td>
<td>18</td>
<td>51</td>
<td>15</td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td>(c) Relation betn. % and decimal</td>
<td>Express $36%$ in fraction</td>
<td>28</td>
<td>11</td>
<td>39</td>
<td>17</td>
</tr>
<tr>
<td>17.</td>
<td>Magnitude of fractional number</td>
<td>Which number is smallest amongst : $-4, 1/2, 1.$</td>
<td>27</td>
<td>15</td>
<td>42</td>
<td>12</td>
<td>✓</td>
</tr>
<tr>
<td>18.</td>
<td></td>
<td>Which number is greatest amongst : $5/6, 7/18, 2/9$</td>
<td>34</td>
<td>19</td>
<td>53</td>
<td>15</td>
<td>✓</td>
</tr>
<tr>
<td>19.</td>
<td></td>
<td>Is it true ? $2/5 &lt; 3/10$</td>
<td>31</td>
<td>20</td>
<td>51</td>
<td>11</td>
<td>✓</td>
</tr>
<tr>
<td>20.</td>
<td>Visualisation</td>
<td>Write down the number of triangles in the figure</td>
<td>26</td>
<td>15</td>
<td>41</td>
<td>11</td>
<td>✓</td>
</tr>
<tr>
<td>21.</td>
<td></td>
<td>Write down the total number of squares in the figure</td>
<td>33</td>
<td>19</td>
<td>52</td>
<td>14</td>
<td>✓</td>
</tr>
<tr>
<td>Sl. No</td>
<td>Head</td>
<td>Item No.</td>
<td>Items</td>
<td>High Total Correct</td>
<td>Low Total Correct</td>
<td>H+L</td>
<td>H-L Evaluation</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------</td>
<td>----------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>-----</td>
<td>----------------</td>
</tr>
<tr>
<td>6</td>
<td>Generalisation</td>
<td>22</td>
<td>Write down the next two numbers in every row</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a) 2, 4, 6, 8, 10,</td>
<td>35</td>
<td>21</td>
<td>56</td>
<td>14 ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) 1, 3, 5, 7, 9,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c) 4, 9, 16, 25, 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d) 40, 35, 30, 25, 20,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Fill up the empty space</td>
<td></td>
<td>55, 66, 77, ____ , 99</td>
<td>36</td>
<td>24</td>
<td>60</td>
<td>12 ✓</td>
</tr>
<tr>
<td>24</td>
<td>Write the sum of all odd numbers lying between 16 and 25</td>
<td></td>
<td>33</td>
<td>20</td>
<td>53</td>
<td>13</td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>Ratio &amp; Proportion</td>
<td>25</td>
<td>Rs 540/- is divided between Lata, Prava and Marami in the ratio 2:3:4. Write down Lata’s share in Rs.</td>
<td>27</td>
<td>13</td>
<td>40</td>
<td>14 ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>26. If a:b = 2:3, b:c = 4:5 what will be a:c ?</td>
<td>31</td>
<td>19</td>
<td>50</td>
<td>12 ✓</td>
</tr>
<tr>
<td>8</td>
<td>H.C.F.</td>
<td>27</td>
<td>Find the H.C.F. of 12, 16, 18</td>
<td>40</td>
<td>25</td>
<td>65</td>
<td>15 ✓</td>
</tr>
<tr>
<td>9</td>
<td>L.C.M.</td>
<td>28</td>
<td>Find the L.C.M. of 4/5, 3/2, 2/3</td>
<td>40</td>
<td>23</td>
<td>63</td>
<td>17 ✓</td>
</tr>
<tr>
<td>10</td>
<td>Unitary Method</td>
<td>29</td>
<td>A tank is filled up in 10 minute by one tap. If there are 2 taps in what time the tank will be filled?</td>
<td>32</td>
<td>18</td>
<td>50</td>
<td>14 ✓</td>
</tr>
<tr>
<td>11</td>
<td>Profit and Loss</td>
<td>30</td>
<td>The cost price of a horse is Rs. 250/- The selling price of the horse is Rs. 270/- What is the percentage of profit ?</td>
<td>29</td>
<td>19</td>
<td>48</td>
<td>10 ✓</td>
</tr>
</tbody>
</table>

✓ : acceptable items
Items of the try-out were analysed one-by-one. In item no. 1, against everyone who got the correct answer was marked one tally in the high half. The total right scores in this half in item No. 1 equals 15. Similarly the total right scores in low half in item No. 1 were 5. For finding out difficulty value of this item, the two figures of high and low halves - fifteen and five were added and it equals twenty. Afterwards lows are subtracted from highs and called out a difference of ten, which appeared as discrimination values of the item no. 1. Therefore the pause for counting item No. 1 is 15.5.20. 10. In this way all the thirty items of the tryout were evaluated for selecting the acceptable items for the final test.

The minimum acceptable high-low difference ought to be at least 10 percent of the group, viz. at least 9 students in a group of 90 students in the top half should get the item correct than the bottom half. When the high low difference is 9 which is 10 percent of the group of 90 students the biserial correlation of this item with the total test will be approximately 100.

Hence all items, evaluation of which fall under acceptable high-low difference value '9' (10% of 90) were accepted for the final test. Here in this evaluation all the thirty items were selected for the final Arithmetical Ability Test. Special care was taken in arranging the items in an easy order.

The final arithmetical ability test includes:

- Number of items: 30
- Working time: 30 minutes
- Score: One score for each correct answer.

Arithmetical Ability Test questionnaire is thus made ready for final printout. As the students selected for the present study are from Assamese medium schools the questionnaires are printed in Assamese taking utmost care. (English version of which is given in Appendix-I and answer sheets of the questionnaire is given in Appendix II).
(ii) **Construction of the Questionnaires on the attitude towards different topics of mathematics course content in H.S.L.C. Examination:**

It is very essential for the teachers in the classroom and for the researchers who are working in the area of school mathematics education, to know the pupils' attitude towards different branches of mathematics and different topics included in their mathematics course content.

As no other readymade tools were available at the time of the present study to assess the pupils' attitude towards different branches of mathematics and different topics in the course content of final Examination, conducted by the Board of Secondary Education, Assam (SEBA) the investigator had to construct one questionnaire for the same. The following steps are followed in constructing the questionnaire.

(a) To get the first hand knowledge of the course content in mathematics in High School stage the investigator have gone through the syllabus in mathematics of H.S.L.C. Examination, conducted by SEBA. Different topics are observed very carefully.

(b) In order to gather first hand knowledge regarding the different levels of attitude towards three major branches of mathematics (Arithmetic, Algebra and Geometry) and about different topics in the course content, fifty students from both the sexes of three High Schools are interviewed in the school campus very informally.

(c) With all these information in the background the questionnaire is constructed.
The questionnaire thus constructed contains nineteen statements, relating to attitude toward different branches of mathematics and different topics in the course content concerned.

The questionnaire is placed before the research guides of the present study and it is considered valid by their opinion. The questionnaire thus constructed is printed very carefully, and thus these are made ready for administration. The questionnaire on course content is given in Appendix III.

**Administration and scoring of the questionnaire scoring relating to course content.**

In the same day and in the same period of administration of the Arithmetic ability Test, the questionnaire on course content is also administrated, after collecting the answer scripts of the Arithmetic Ability Test.

The printed copies of the questionnaire are distributed to each of the students (one each). The concerned procedure of answering is explained to them. There are nineteen statements in the questionnaire. The students are asked to give tick mark (✓) against each of the items, in the same sheet according to their level of difficulties under the headings "very difficult", "difficult", "not difficult". The questionnaire in course content is given in the appendix II (a).

**Scoring of the questionnaire: -**

The number of students giving tick marks under different headings are counted separately and number and percentage of the student giving tick mark under the heading “very difficult” are found out (Table 3.2)
III) MATHEMATICAL INTEREST INVENTORY (MII)

Mathematical Interest Inventory is a standardised Test Inventory, constructed and standardised by L.N. Dubey (Educational Psychology and Guidance College, Jabalpur), to measure the level of interest in mathematics of the pupils of high school standard. The investigator thought that the knowledge of the responses of the pupils against the items in the inventory will enable the teachers to build up interest and to motivate them in acquiring interest in mathematics among the pupils who lack in it. It is always true that, inspite of his better intelligence and aptitude, his likes and dislikes may affect the achievement in mathematics along with the general academic achievement of the pupil.

There are forty items in the Mathematics Interest Inventory (MII), of which twenty items indicate liking and twenty items indicate disliking for mathematics. The items of the inventory are of very practical nature. Every statement of the items can touch the mind of the pupils concerned very easily, so that acceptance or rejection of the statement could be given in a straightforward way.

The MII is an inventory in English version. The investigator thought that it might create problem for use among the students of the sample, which are selected from the Assamese medium schools only. Therefore the original version of the MII is translated into Assamese under proper supervision.

The translated version is printed for administration. All possible carefullness are taken on maintaining original meaning of the statements, phrase, situation and sequences. The Mathematics Interest Inventory is thus made ready for administration. Mathematical Interest Inventory is given in Appendix IV and Scoring of Mathematical Interest Inventory is given in Appendix V.
ADMINISTRATION AND SCORING OF M.I.I.

The investigator carefully follows the instructions given in the test manual of the author for the administration of the test.

The students are explained that through this inventory their actual and true feelings about mathematics and about the mathematics class, mathematics class teachers are sought. They are informed that it will be kept most confidential. They are instructed to give 'tick' mark (✓) on 'yes' or 'no', which are given against each statement of the inventory according to their acceptance and rejection of the statements.

The students are asked to fill up the bio-data form given on the front page of the MII according to the instruction given. The MII is administered in the mathematics period in the class routine of the schools. The copies are collected after the period is over.

SCORING OF M.I.I.

It is already mentioned that there are forty items in the M.I.I., twenty items indicating liking and twenty items indicating disliking for mathematics. The positive response on the item indicating liking are awarded one mark and for negative response on the same item are awarded 'zero' mark. The reverse order is followed for the items indicating disliking for the subject; i.e. one mark is allotted for negative response and zero for positive response.

In the end, the total marks obtained are awarded, which are considered to be the respective interest scores of each pupil.
IV) THE MADHUKAR PATEL’S INTELLIGENCE TEST. (M.P.I.T.)

M.P.I.T. is a standardised test to measure intelligence of children reading in standard VIII, IX, X. The test is a unique test, independent of any form of school achievement. The test consists of geometrical figures, designed to test the students' power of abstract thinking, reasoning and space perception and visualization. The test is independent of any form of socio-cultural background of the students and its language is a geometrical one. The test gives equal opportunity to each of the students to express their ability. The M.P.I.T. booklet and answer sheet sample are attached in appendix IV.

The test consists of four sets of test items and in total there are eighty items. The investigator, after consultation about the nature of the test, with the teachers of some of the selected schools came to know that the students (who are selected from the Assamese Medium, Schools only) are not at all acquainted with such type of test. These types of test items are quite new to our school students especially in our Northeast.

The investigator administered the M.P.I.T. to ten girls and twenty boys, of one of the selected schools and confirmed that, most of the pupils did not even touch the last set of the four sets of the items in M.P.I.T. There was complaint like "It is very hard". The investigator, with due permission of the expert body concerned with the present study, selected only three sets of test items out of the four sets, thereby total number of test items being sixty.

The booklet containing the test items and the answer sheets are printed for administration. The answer sheet for each of the students is also printed. Answer sheets of M.P.I.T. is given in Appendix VII and M.P.I.T. Intelligence Test by Dr. Madhukar Patel is given in Appendix VIII.
ADMINISTRATION AND SCORING OF M.P.I.T.

The investigator carefully follows the instructions given in the test manual of the author for administration of the test. Accordingly the following steps are followed.

a). The students are seated comfortably with two pupils in one bench.

b). Rapport is established between the investigator and the students by explaining the purpose of the test.

c). The printed booklets containing the test items and the answer sheets are distributed among the students - one booklet along with one answer sheet to each student. The investigator explains the sample of the test items clearly to the students, which gives hints for answering the different types of the test items. It can be mentioned that, at the first page of the booklet containing the test items, sample items for each set with tricks to answer them are illustrated. The details of the procedure to write the answer in the answer sheets are explained.

d). After getting the green signal for readiness from the part of the students, the investigator asks the students to start.

The students are asked to fill up the bio-data forms given in the answer sheets. The maximum time allotted to complete the test was forty minutes. After completion, the investigator collected both the booklets and the answer sheets from the students and thanked them for their co-operation and enthusiasm.
SCORING OF M.P.I.T.

There are sixty items in the three sets selected from the M.P.I.T. One mark is allocated for each of the correct answer and zero mark for the wrong answer. The total marks for the whole test is sixty. The total marks obtained by each individual student are added, which is considered as their intelligence scores.

With the help of the tools described above the required data are collected from ten Assamese Medium Secondary Schools of Greater Guwahati. During the process of data collection, the investigator is very happy to see that, the Head of the Institution concerned, the subject (Mathematics) teacher and the students of each and every school taken under the study, are found to be very co-operative, very anxious and very helpful in every stage. It is already mentioned that, the head of each institution under consideration for the present study is personally approached by the investigator for permission, allotment of time and other formalities.

3.9 SYSTEM OF ANALYSIS OF DATA

The data thus acquired are thoroughly checked and made ready for final analysis. Total Number of data is five hundred. The investigator scores the data on questionnaire on arithmetic ability, course content, MPIT, mathematical interest inventory and achievement in arithmetic following the given instruction as described earlier. Thereafter the data is analysed with the help of the computer and necessary statistics such as means, standard deviation, correlation etc. and ‘t’ values of different variables, are calculated. In analysing the data the investigator takes the help of graphical representation and percentage calculation where necessary. The details of all this analysis are described in the next chapter.